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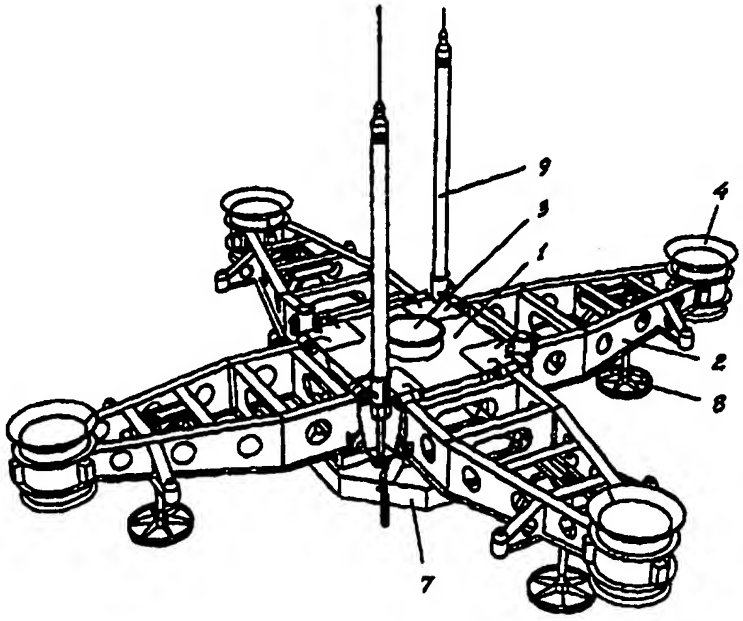
(54) Title: TEMPLATE CONSTRUCTION FOR DRILLING SUBSEA WELLS FOR OIL AND GAS



(57) Abstract

There is disclosed a subsea foundation/template construction comprising a polygon, preferably square central body (1), to which body (1) there exists at least one horizontally hinged arm (2) so that the arm(s) (2) may be pivoted from a mainly vertical to a mainly horizontal position over an angle of about 90°. The present foundation/template construction comprises parts which may be assembled on the drilling site and which may be submerged through a conventional moonpool of a drilling rig without the need for special vessels for transporting or mounting the foundation/template.

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TEMPLATE CONSTRUCTION FOR DRILLING SUBSEA WELLS FOR OIL AND GAS.

The present invention concerns a drilling template and well foundation for two or more subsea units for petroleum production equipment units, infra called foundation/template construction, and which may be handled and installed through conventional moonpool opening whereof the dimensions normally are e.g. 6m x 6m. The device according to the invention comprises a central support unit to which there are mounted arms. Such a construction makes it possible to simplify transportation, submerging and mounting the foundation/template construction on the drilling site. Additionally it is disclosed a protection structure for each of the subsea drilling holes with mounted production equipment, e.g. valve trees, manifolds, pipe tightening equipment and connecting equipment. Further advantages with the device according to the present invention is that it may be mounted and operated by using conventional mobile drilling rigs, i.e. without using lifting ships or crane ships. All components are of a size and of such a weight that they may be handled without using special equipment on the drilling rig.

The process chosen when expanding a subsea oil field is a compromise between requirements concerning the draining of the well, safety during production and economical factors. This has resulted in that the main part of the development within subsea petroleum reservoir installations has got a unified design and have normally been operated by using large and heavy foundation/template constructions having been built for this purpose, integrated with trawl-resistant protection structures. These demand heavy and large lifting vessels for being installed prior to drilling wells and mounting the drilling head by using conventional mobile drilling rigs.

A geographical area being associated with a petroleum production rig may have a number of foundation/template constructions and satellite wells being normally bound to each other or directly to the production platform by using subsea pipelines for further handling of the petrol and transport ashore. The foundation/template constructions comprise normally a number of well head equipment gear (valve trees), manifolds for collecting or distribute well liquids, control equipment for the wells as well as pipeline/control lines. This represents today the solution used for extracting exploitable subsea petrol fields. Together with the need to find economical solutions for exploiting small fields at sea and expand the draining capacity at already existing reservoirs, the reduction of the costs for foundation/template constructions has significant advantages. One way to achieve this is to reduce the size, the weight and the complexity of the foundation/template construction for thus reducing the fabrication costs. In addition the installation costs are reduced dramatically if the mobile drilling rig being used to drill the wells, also may be used to install the foundation/template construction the associated equipment for thus to eliminate the expenses by using specialized lifting vessels.

Furthermore the development of a standard foundation/template construction, which also fully may be operated by any mobile drilling rig independently from the design of the well or the seafloor conditions, is considered to be of great importance and represents a significant advantage. The optimum number of standardized foundation/template constructions may thereby be used for adaption to the special subsea drilling area. This is especially interesting when considering draining a marginal oilfield.

The economical advantages by reducing the total time for project development are self-evident.

In addition the device according to the present invention is suited for being transported and installed with one and the same vessel which also is employed for drilling and completion of the wells and for installing the necessary protection of the subsea equipment.

Previously there has been made attempts to solve the above indicated problems, but without success.

Thus there is in NO patent 152.060 disclosed a large and heavy subsea template as well as the submersion thereof. The subsea template being disclosed in this prior Norwegian patent comprises admittedly horizontally hinged and pivotable arms, but such a device must all the same be mounted and transported with especially constructed vessels on account of its size and weight, something which the present applicant has sought to avoid with the present invention. The device disclosed in Norwegian patent no. 152.060 may neither be installed through a conventional moonpool in existing drilling rigs.

In GB patent 2.202.257 there is also disclosed a foundation/template construction for drilling single subsea wells, and comprising pivotable supporting legs, but such a foundation/template construction is only meant for one singe drilling hole. Furthermore the integration/connection between each single drilling frame according to this prior art patent will not be performed through hinging, and the connection is done at the sea floor. These disadvantages is sought to be removed with the present invention.

The main purpose of the present invention is to provide a subsea foundation/template construction system (subsea template with protection of manifold, valve trees and other necessary production equipment) and which may be installed through the moonpool of a conventional drilling

rig without the need for using heavy lifting vessels and other special equipment for the operation. Another purpose of the present invention is to produce a foundation/template construction system which is easy and simple but still has the necessary structural strength, which is economical to produce, assemble and use, to give a foundation and protection for all the necessary subsea equipment (with or without a protective structure).

Still another purpose of the present invention is to provide a standard foundation/template construction having sufficient flexibility in its design to be used in drilling fields with a large number of wells, by assembling several foundation/template constructions. Such a solution will additionally be less dependent on seafloor conditions than a conventional foundation/template construction for more than one wells.

Still another purpose of the present invention is to produce a construction for protecting the subsea installation against over-trawling and against falling objects and which also may be transported without using specially constructed vessels and equipment and be installed via the moonpool opening. The protective structure for each of the subsea modules (valve trees, manifolds and other necessary equipment), may independently be disassembled and brought in, and in this manner the other modules are protected during activities being performed on one of the modules. Additionally the device according to the invention allows an improved possibility for using remotely controlled vessels (Remote Operated Vehicles, (ROV)).

Further purposes and advantages of the present invention will be apparent from the further detailed disclosure and figures wherein:

Figs. 1 and 2 show the foundation/template construction

according to the present invention without assembled subsea equipment and protective structure, seen from above and from the side, respectively;

Fig. 3 shows the device according to the present invention seen form the side with mounted representative subsea production equipment, but without a protective structure;

Figs. 4 - 7 show different stages of the mounting of leading elements and the foundation/template construction according to the present invention;

Fig. 8 shows a mounted end nivellated foundation/template construction according to the invention with a temporary leading base and with a mounted first part of a protective structure with an integrated permanent leading base;

Fig. 9 shows the mounting sequence of the protective structure for subsea equipment where each of the three sections in which the structure is divided, is present as an integrated part of the subsea equipment (manifold, valve trees, etc.);

Fig. 10 shows a perspective picture of the foundation/template construction according to the present invention at the mounting to a temporary leading frame with leading strings and elevated arms;

Fig. 11 shows a perspective picture of the foundation/template construction according to the invention in mounted condition before drilling through the arms has started;

Fig. 12 shows a perspective picture of the foundation/template structure according to the invention in mounted condition and with a mounted protective structure over all, except one, module; and

Figs. 13 and 14 show the design of one embodiment of a supporting device for the arms of the foundation/template construction according to the invention.

The structure of the foundation/template construction according to the present invention is shown in figs. 1 and 2, and comprises a central foundation 1 having the shape of a polygonal body, (in the figure shown as a mainly square body, even if other designs, e.g. triangular, pentangular, hexangular etc., are possible). To at least one of the side edges in the polygonal body 1 there is horizontally hinged a in the vertical direction pivotable arm 2, said arm 2 having a swing over about 90°, i.e. from an upright position in relation to the upper surface of the centre foundation to alignment with the upper surface of the centre foundation.

The centre foundation comprises additionally a mainly centrally located hole 3 through which there may be located a leading pipe (see the disclosure infra).

The centre foundation will usually be made of metallic plates or beams, e.g. of metal such as aluminum or other metal alloys. The strength and the composition of such metal or alloys may be determined by the person skilled in the art in each separate instance, but materials such as steel, optionally strengthened composite materials etc. may be used.

The supporting arms 2, being pivotally connected to the central foundation 1 at its upper side edges, have also preferably the same plate or beam construction and comprise, also preferably, the same type of materials as the central foundation 1. Additionally the supporting arms 2 comprise penetrating and mainly vertically running holes 4 for the location and penetration of a drilling string and lining pipes. In fig. 3 there is suggested the location

of different types of conventional well equipment 13,15,20 on the centre foundation 1 as well as on the holes 4 of the arms 2. In addition to the penetrating holes 4, there may in the beams or spokes comprising the arms 2 be located securing devices 5 for additional supporting devices 8. The supporting devices, e.g. supporting plates or legs (mud mats) are present to nivellate and support the construction when placed on a sea floor of varying consistency, e.g. on a clay or silt sea floor (see figs. 2, 13 and 14).

The subsea foundation/template construction according to the invention comprises in a preferred embodiment, a lightweight steel frame which also may comprise independently protected modules (see infra) for each installed subsea well or other equipment.

Typical subsea equipment is valve trees, manifolds and pipe-tightening modules, but the flexibility of the design of the foundation/template construction according to the present invention will also allow other subsea equipment, e.g. pumps, pigging equipment etc. to be installed.

The foundation/template construction itself comprises a centre foundation 1 and similar or different arms 2 hinged thereto.

The main function of the centre foundation 1 is to support the arms 2 and the subsea manifold module 20. The centre foundation itself is designed to be carried on a cemented leading pipe 6 having been placed vertically in a predrilled well through the pre-installed leading frame 7 (Temporary Guide Base (TGB)) on the sea floor.

The centre foundation 1 and the arms 2 have leading poles 9 preferably being compatible with an API standard of 6 ft. (2586 mm) centrally located in a square about the

permanent leading frame (Permanent Guide Base) 13.

The centre foundation 1 and the arms 2 are produced and tested on the fabrication site where all the tolerances may be adjusted. The arms may be disassembled and if the components of the foundation/template construction are sufficiently light and small, they may be transported by road from the production site to a key plant with common trucks or lorries and with transport vessels or vehicles to the rig where they are lifted aboard with a deck crane. By using standard rigging equipment the foundation/template construction is assembled in the moonpool area of the rig with its arms in an upwards pivoted position like an inverted umbrella. The height of the assembled foundation/template construction is less than the normal free height under the drilling deck for thereby to allow the closed foundation/template construction to be pushed along the lower deck to the moonpool of the rig. Standard drilling pipes are used with the mounting equipment to lower the assembled and closed foundation/template construction to the sea floor where it is placed on the pre-installed conventional leading frame 7. The hinged arms 2 are pivoted outwards and are locked into position in a conventional manner. By using a remote-controlled vehicle additional devices for installing the arms 2, e.g. stabilizing props (mud mat jacks) for muddy or silt seafloor conditions 8, may be adjusted individually to nivellate the foundation/template construction before cementing a central pipe 6.

With reference to the figs. 4 - 7 there will now be disclosed the method for locating/mounting the embodiment of the foundation/template construction according to the invention being shown in the figures.

In figs. 4 and 5 there is shown the location/mounting of a temporary leading frame (Temporary Guide Base (TGB)) 7 by

using a drilling string 10 and a running tool 11. This frame is of a conventional type and its installation may be performed in a conventional manner. Through this leading frame (TGB) there may be drilled holes in the ground in a conventional manner by using a drilling string 10.

After placing the leading frame (TGB) 7 on the sea floor and drilling a hole, the centre foundation 1 according to the present invention with is assembled arms (the foundation/template construction) in a closed position, is lowered onto the leading frame (TGB) 7 (see the disclosure supra for the mounting and lowering of the foundation/template construction). For placing and mounting the centre foundation 1 on the leading frame (TGB) 7, there is mounted a leading pipe 6 through the central hole 3 of the centre foundation as well as through the central hole of the leading frame (see fig. 7). The leading pipe is lowered together with the foundation/template construction.

After having placed the centre foundation with the arms 2 in an upright position onto the leading frame, the arms 2 are lowered (fig. 7) by pivoting them about their hinged pivot axis. The arms 2 are then locked in their correct positions to the central foundation 1 by using conventional remote-controlled units and locking devices 14. The locking of the arms 2 to the central foundation 1, may, as an example, by using adjustable locking pins 14 (see fig. 7). The complete subsea foundation/template construction is then finely adjusted/nivellated to lie horizontally so that the leading pipe 6 lie in an upright and vertical position in the drilling hole. Then the leading pipe 6 is cemented in place in a vertical position in the drilling hole.

In connection with adjustment of the supporting arms 2,

the devices 8 (mud mats) will have a double function, i.e. carrying the supporting arms 2 as well as horizontally adjusting the same.

With this the mounting of the foundation/template construction according to the invention is complete, and further subsea operations may be performed via this foundation/template construction. Through the holes 4 in the arms 2 of the foundation/template construction there is drilled wells in a conventional manner with subsea blow-out valve trees placed on the permanent leading frame (Permanent Guide Base (PGB)) 13 with a mounted lower part of a protection structure 17 (fig. 8).

The subsea production equipment which is being used will, as mentioned supra, be subject to damage of different types, e.g. falling objects from above or over-trawling by fishing boats etc. To protect the petrol-winning equipment there will preferably be located protecting hoods over the equipment and which lie over each single well. Such protective hoods is of great importance for protecting the subsea equipment and the foundation/template construction according to the invention, and with the present foundation/template construction it is preferred to use protecting hoods being divided in sections.

The installation of such hoods is shown in fig. 9 wherein there also is shown the sectionvise division of the hood assembly. The lower part 17 of the hood assembly is mounted and installed together with permanent guidance frame (PGB). The middle part 18 of the hood assembly is installed and mounted together with the valve tree 15 or other production equipment being placed on top of the lower section. The upper part 19 of the protection structure is installed and finally mounted together with the valve tree cap (tree cap) 16 on top of the middle part 18. In figure 9 there is shown an assembly of three parts of

the protection construction which is relevant for installation and finishing of production (or injection) wells. When installing the manifold on the central foundation 1 and e.g. tightening modules on one of the arms 2, the two upper sections 18,19 of the protection structure is installed mounted toghether in one operation.

The foundation/template construction according to the invention will be illuminated infra in connection with one embodiment example. The indicated embodiment example being relevant for a conventional drilling wherein the wells are established with a 30" (762 mm) lining pipe, is in no way to be regarded as limiting for the invention. In other drilling techniques, e.g. "thin hole drilling", some of the dimensions may be altered.

In the indicated embodiment of the figures the central foundation 1 comprises a quadratic body with side edges by a size of 2900 mm. Through the central foundation 1 and the arms 2 there runs a penetrating hole 3,4 being 914,4 mm in diameter. This makes room for a lining pipe (6,12) of 762 mm in diameter running through the hole 3,4. The distance between the centre of the central hole 3 and the centre of the holes 4 running through the arms 2, is 6000 mm. The height of the foundation/template construction (arms 2 and central foundation 1) is 1000 mm. On the arms 2 the distance from the hinges to the inclination of the reciprocal parts of the arms is 1250 mm and the length of the arms where the parts incline towards each other towards the centre of the penetrating hole 4 is 3250 mm. In this embodiment it is preferred to use joined welded steel plates with a material thickness of between 10 and 50 mm.

The supporting devices 8 for the arms 2 being shown in figs. 13 and 14, comprise in this embodiment circular discs ("mud mats") with a diameter of 2000 mm. These discs are hinged by using a ball bearing to the adjustable

arms, said arms in their turn being hinged at the mounting point to the arms 2. Such a construction has as an effect that the supporting devices 8 may be adjusted in any angle in relation to the foundation, but it will be pointed out that this embodiment is only one of a number of possibilities, since the mechanical properties of the sea floor require varying demands as to size and design of the "mud mats".

In the disclosure given supra, the foundation/template construction according to the invention has been indicated with respect to the embodiment shown in the figures, but obvious variations of the construction will be evident to the person skilled in the art without departing from the idea behind the foundation/template construction.

C l a i m s

1. Subsea foundation/template construction for petrol production whereon there may be mounted further production equipment (15,16,17,18,19,20), said foundation/template construction in assembled condition may be placed over a pre-drilled hole (12) in the sea floor, where the foundation/template construction comprises a polygon, e.g. a square, central body (1),
c h a r a c t e r i z e d i n that it through the polygon central body (1) runs one single penetrating hole (3) wherein there may be placed a leading pipe (6) for the founding of the construction, to which central body (1) there is mounted at least one horizontally hinged and vertically pivotable arm (2), where said arm(s) (2) may be locked to the central body (1) in a mainly horizontal position, and where the arm(s) prior to mounting/locking to the central body (1) is/are pivotable from a mainly upright position to a mainly horizontal position over an arc of about 90° in relation to the central body (1), where the arm(s) (2) in their distal area from the central body (1) comprise(s) one single hole for the penetration of further guidance pipes (15) running mainly parallel to the leading pipe (6) running through the central body (1).

2. Foundation/template construction according to claim 1, c h a r a c t e r i z e d i n that the arm(s) (2) comprise(s) nivellation/supporting devices.

3. Foundation/template construction according to claim 1 or 2,
c h a r a c t e r i z e d i n that there over the central body (1) and optionally the arm(s) (2) may be mounted protecting structures (17,18,19).

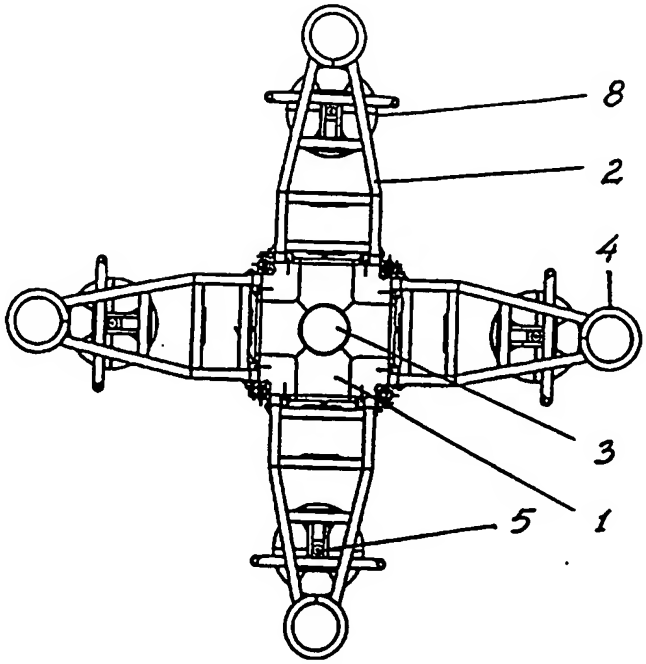

Fig. 1

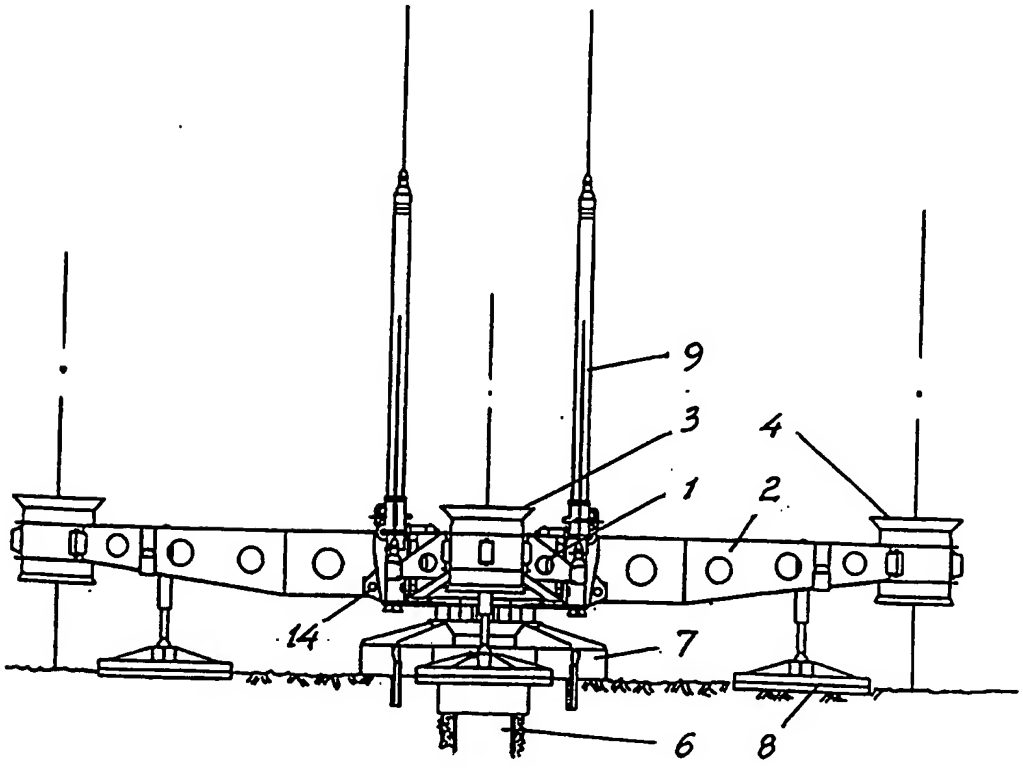

Fig. 2

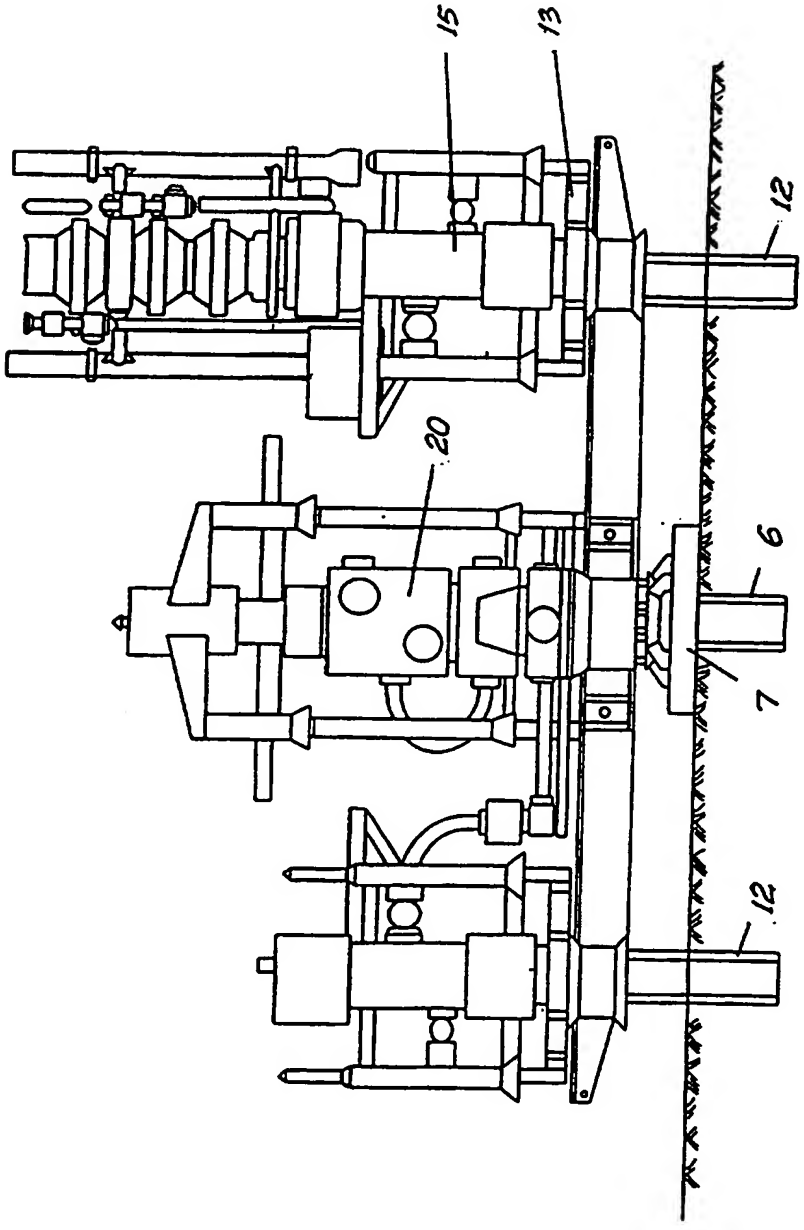

Fig. 3

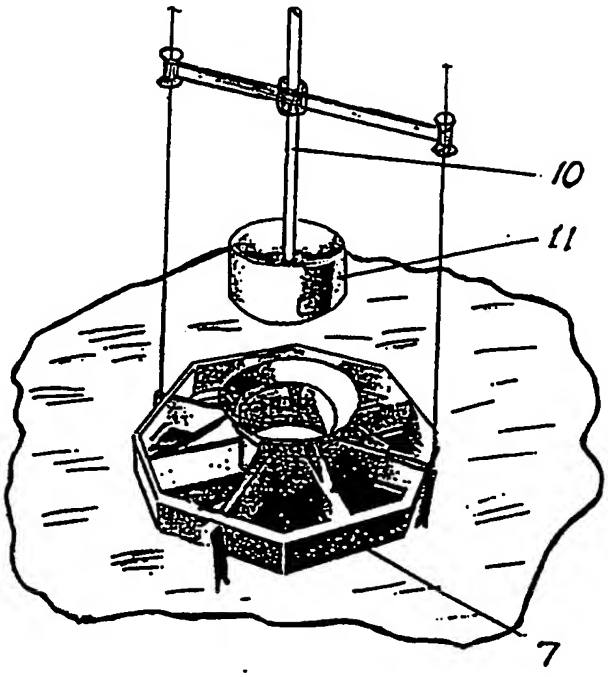

Fig. 4

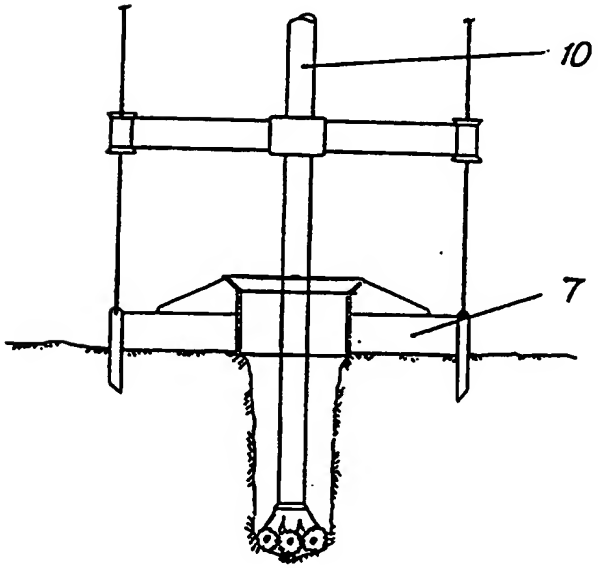

Fig. 5

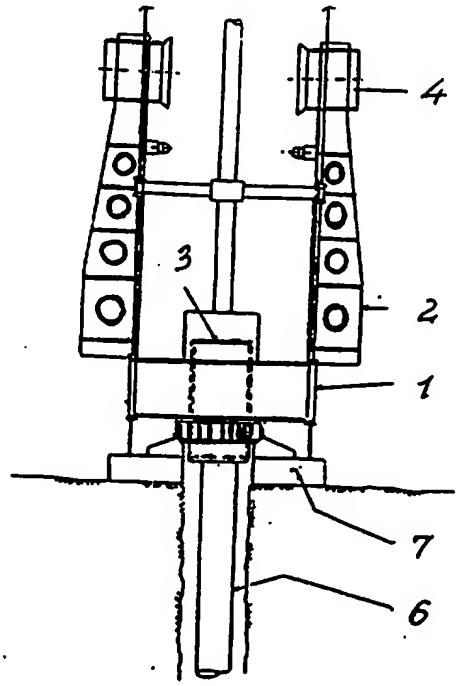

Fig. 6

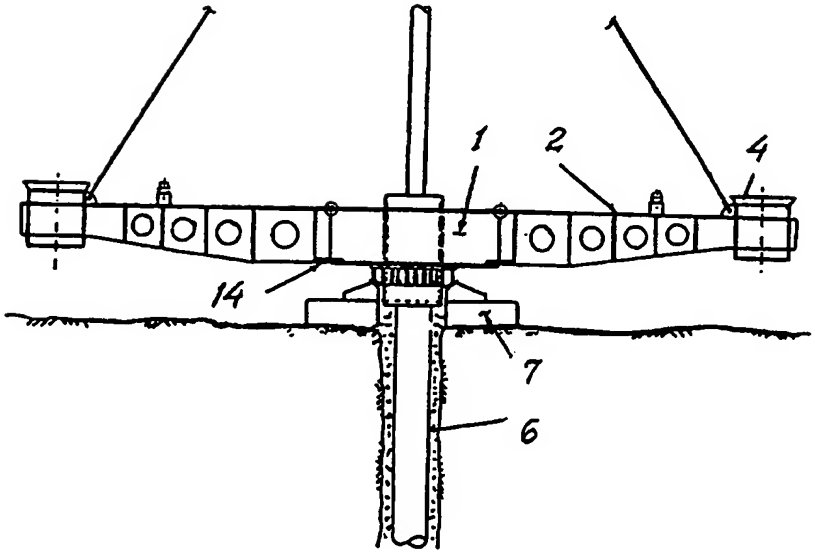

Fig. 7

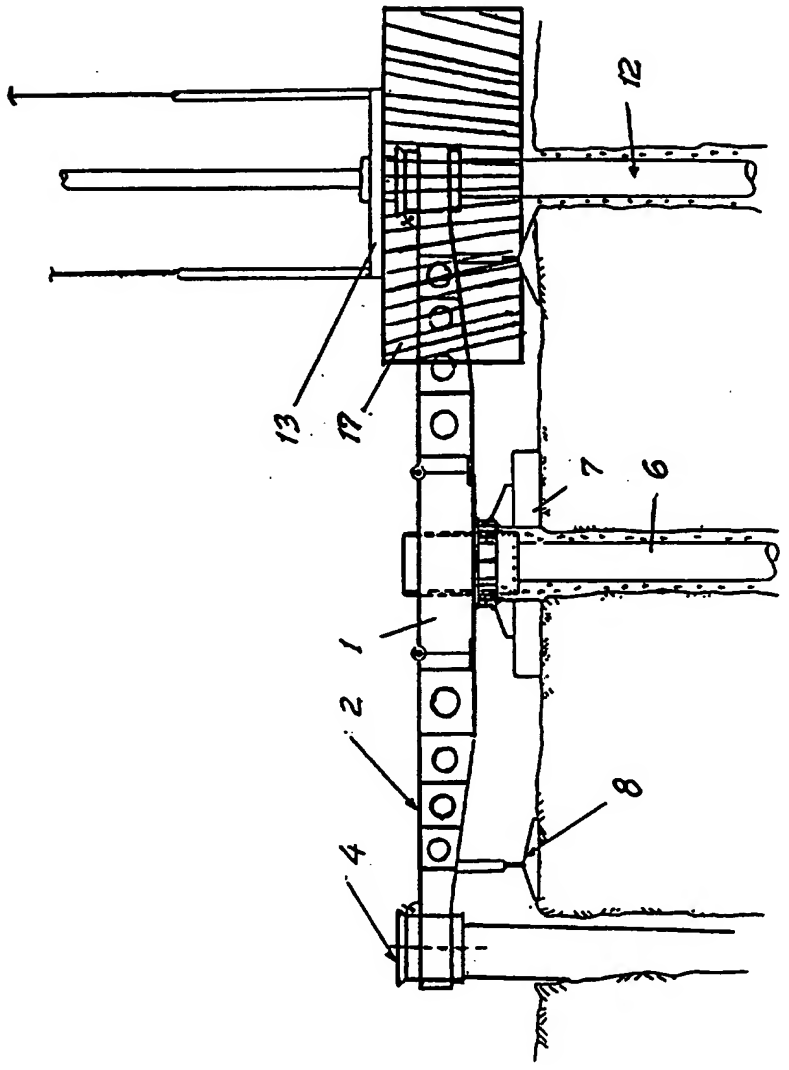

Fig. 8

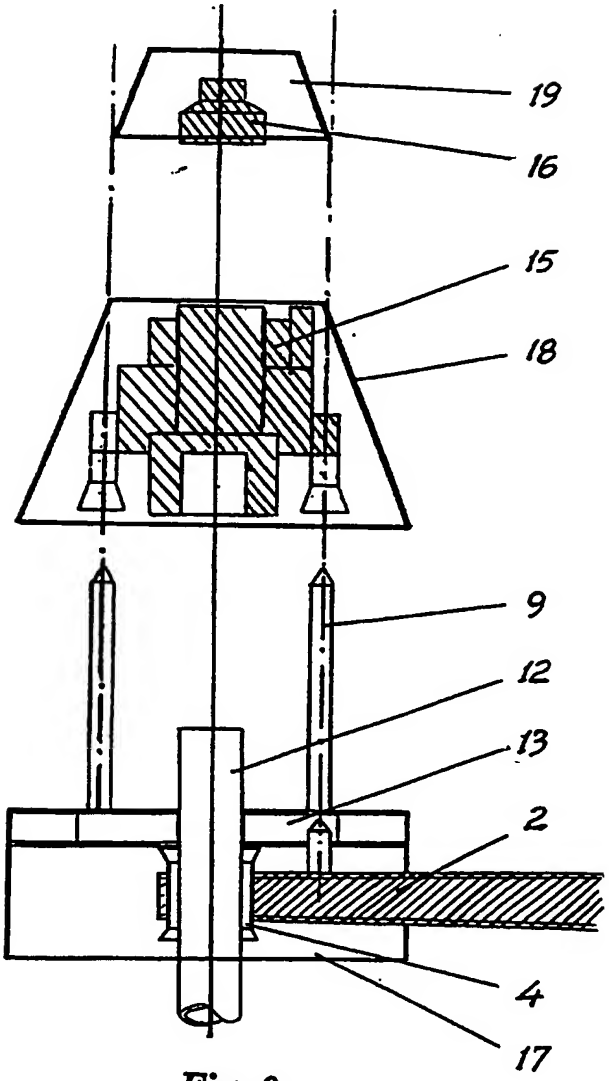

Fig. 9

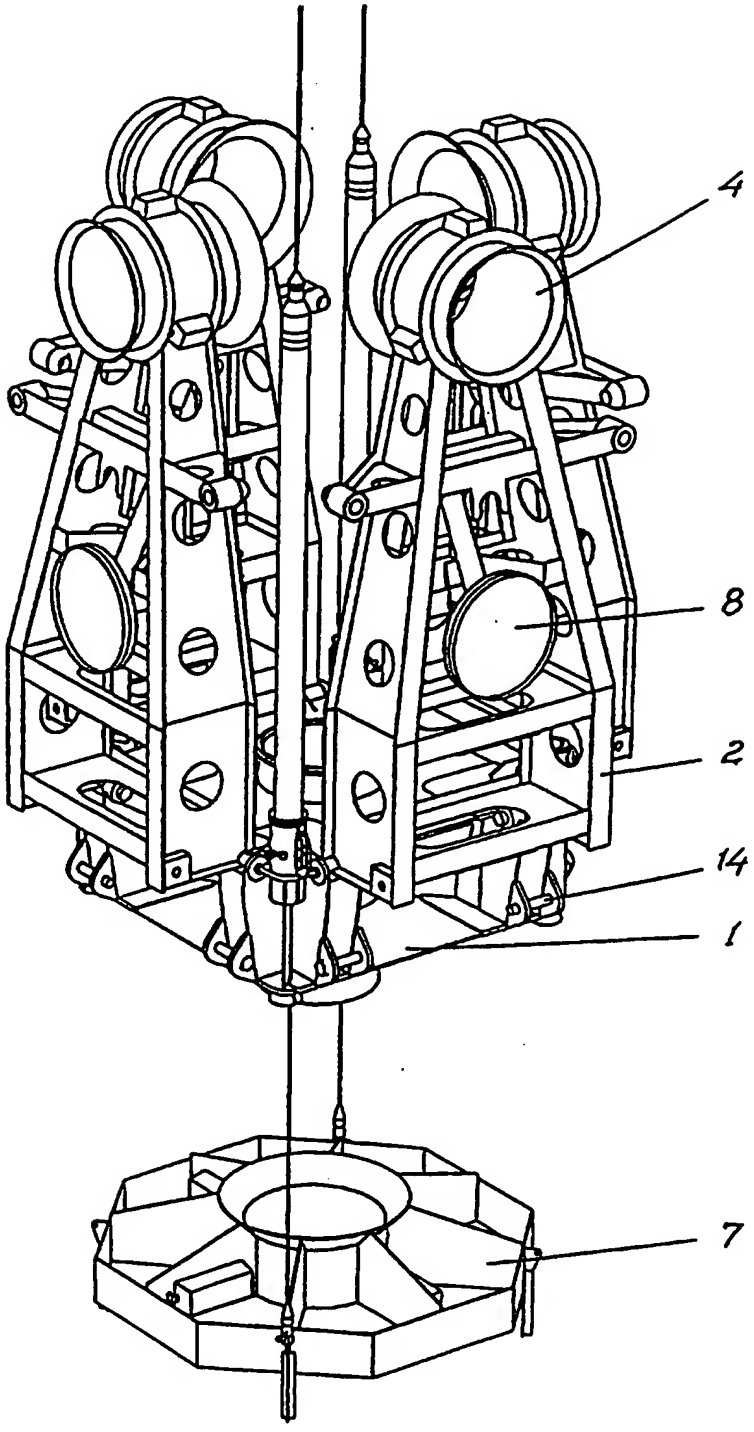

Fig. 10

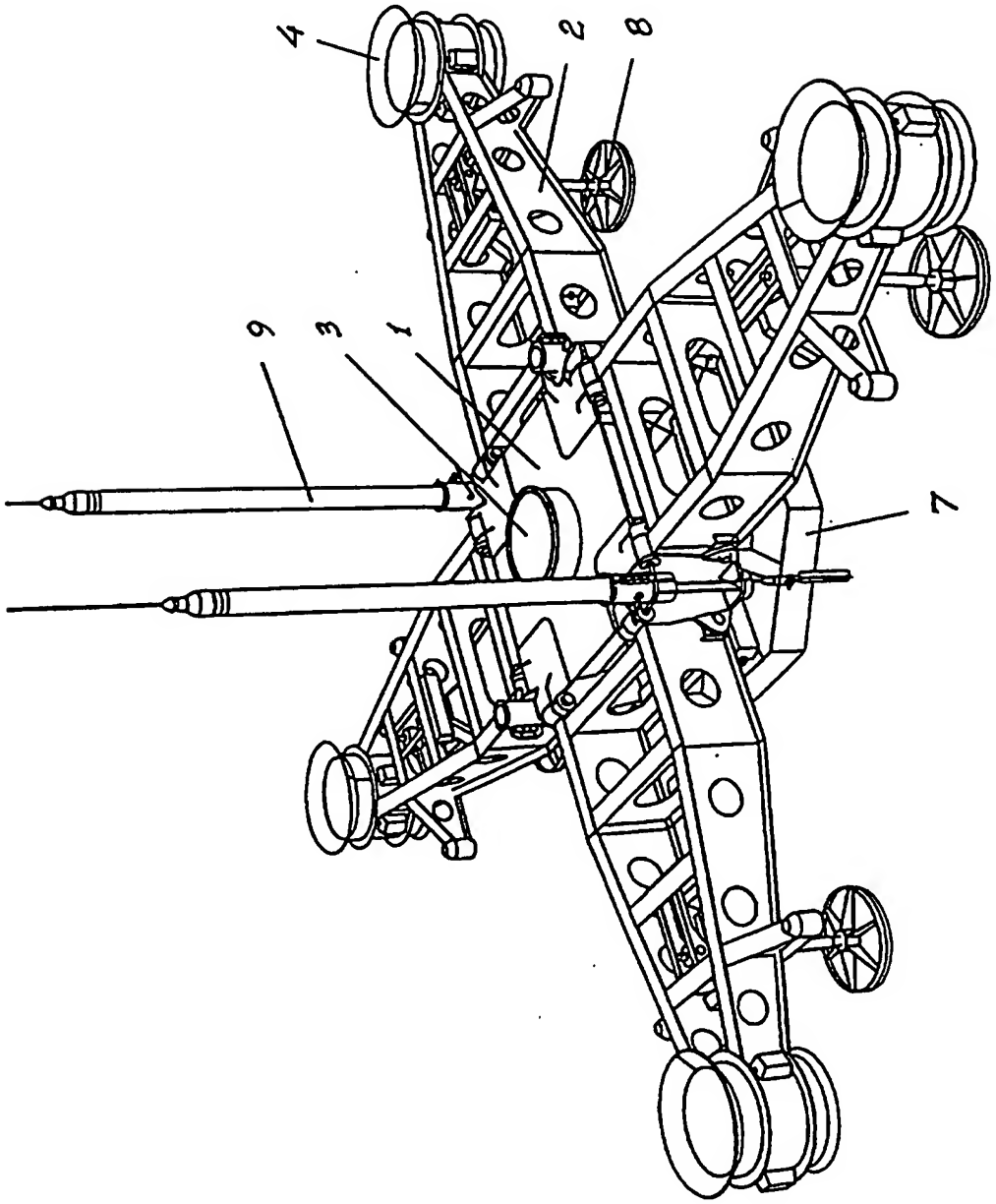

Fig. 11

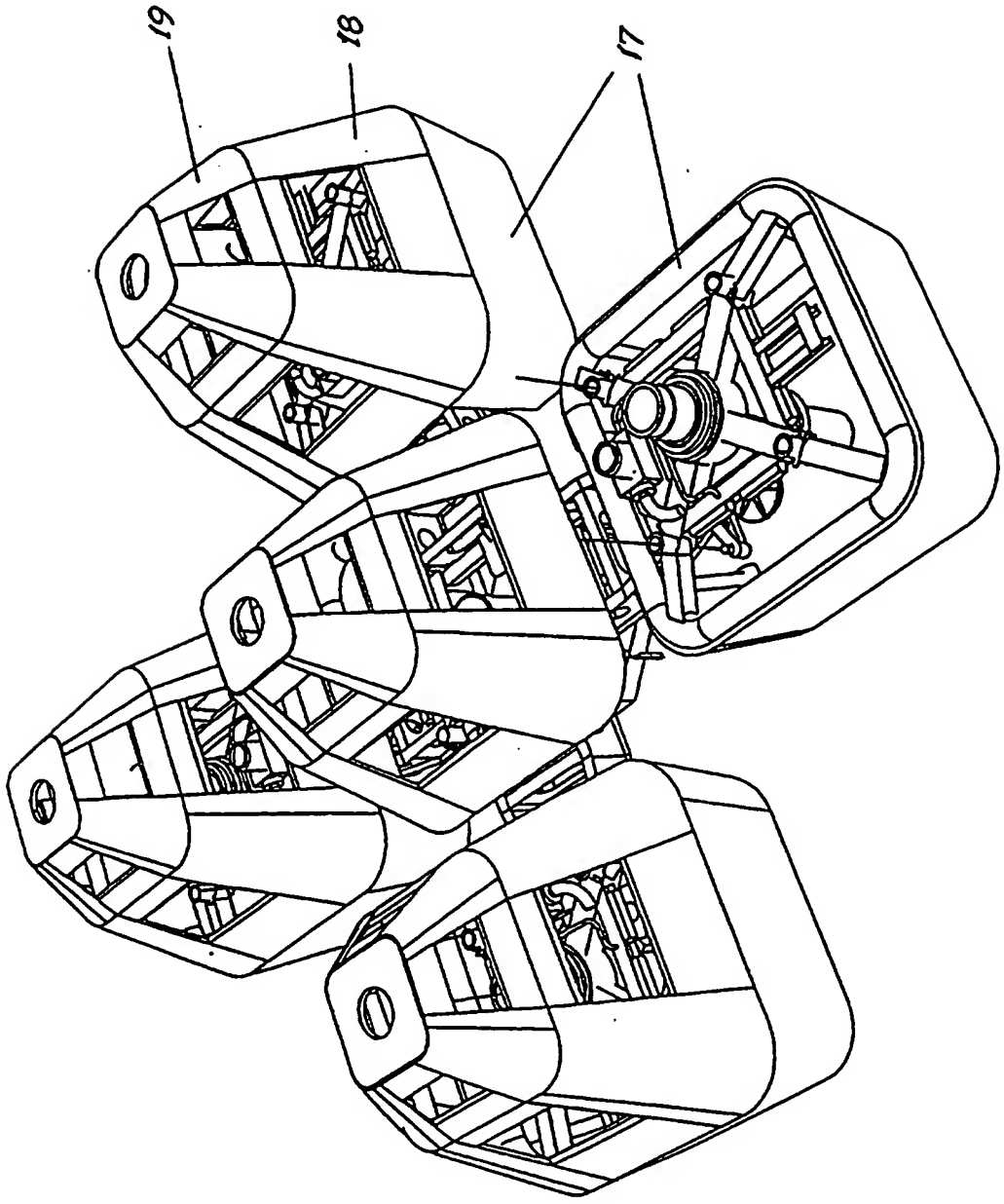

Fig. 12.

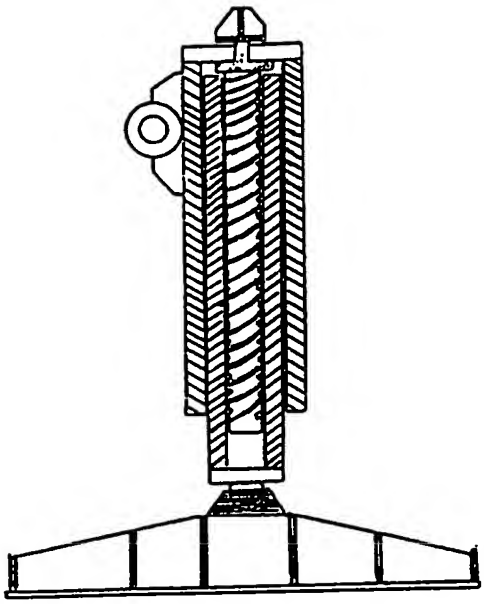

Fig. 13

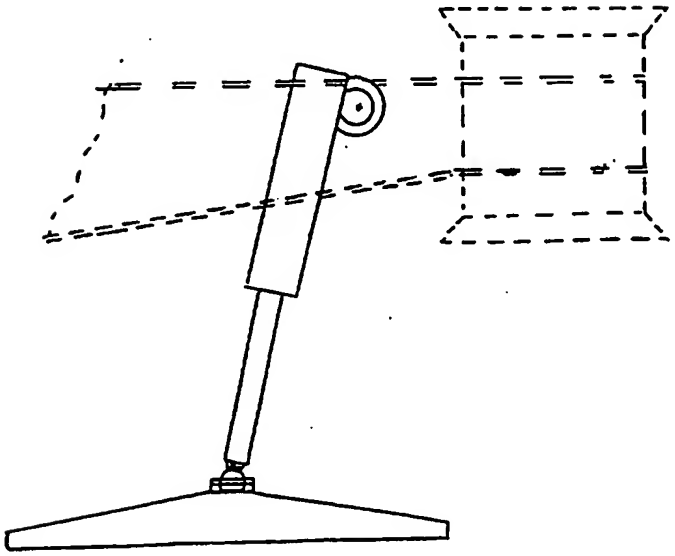

Fig. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 95/00137

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: E21B 7/128, E21B 33/035
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	NO 139231 B (SAGA PETROLEUM A/S & CO.), 16 October 1978 (16.10.78) --	1-3
X	NO 152060 B (STANDARD OIL COMPANY), 15 April 1985 (15.04.85), especially the claims and the figures --	1-3
X	GB 2202257 A (THE BRITISH PETROLEUM COMPANY PLC), 21 Sept 1988 (21.09.88), page 2, line 25 - page 4, line 3, figure 2, claims 1-11 --	1-3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
5 December 1995	11 -12- 1995
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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